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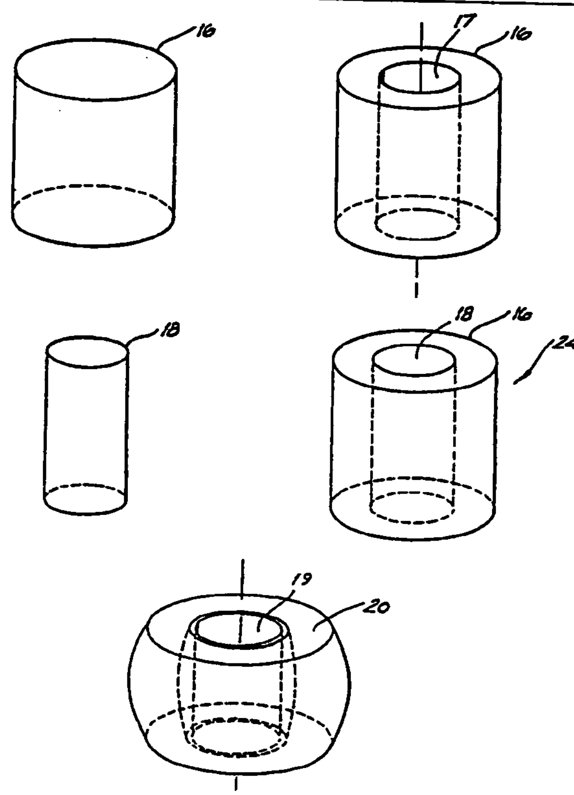
(54) Title: DRILL CASING CONNECTORS






(57) Abstract

Male or female connector portions (52, 53) of a connector (50), consisting of annular sections (52, 53, 54, 56) which are forged connected to form a laminated structure, the connector portions (52, 53) are formed from a number of layers of metal, plastically deformed by a punch in a forging process.

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# DRILL CASING CONNECTORS

## FIELD OF THE INVENTION

The present invention relates to the forge connecting of metal layers and more particularly but not exclusively to connectors employed to join lengths of pipe during a drilling operation such as an off-shore drilling operation. The connectors consist of a set comprising a male and a female portion.

## BACKGROUND OF THE INVENTION

The manufacture of annular rings and flanges having different properties in different areas presents expensive and technically difficult problems where, for instance, strength, weldability, corrosion resistance, and ductility are required in different parts of the one product.

Many types of such rings are used in the oil and gas drilling industry. One such type are known as Connectors.

Connectors consist of a male and female connector portion which join to link lengths of pipe during an off-shore drilling operation. The male portion is externally threaded or profiled and the female portion is internally threaded or profiled. Each portion is welded to an associated length of pipe. The pipe lengths are a lining (or bore-casing) for the drilled hole as it is being drilled.

For the connectors to function correctly, the threaded or profiled sections of each connector portion must withstand considerable stress, and yet each portion must be easily welded to a length of pipe.

In view of the above constraints, each connector portion is usually formed of a relatively strong material. Inherently such strong materials are difficult to weld unless the connector portion and the extremity of the pipe are pre-heated to facilitate welding.

The above process of welding each connector portion to its associated length of pipe is time consuming and may result in poor weld properties and poor weld quality.

## OBJECT OF THE INVENTION

It is the object of the present invention to overcome or substantially ameliorate the above disadvantages.

## SUMMARY OF THE INVENTION

There is disclosed herein a unitary structure of metal layers, said structure being of a generally annular configuration and consisting of a laminated structure so as to have a radially inner section and a radially outer section forge connected to the inner section so as to be integrally bonded thereto, and wherein one section consists of a layer of strong

metal to provide a portion of the structure with mechanical strength, and the other section consists of a layer of more ductile metal to provide a portion of the structure with another property not provided by said one section.

Preferably the above unitary structure includes at least a third section consisting of a third metal layer, with the sections being arranged generally concentric and forge connected so as to be intregrally bonded together, and wherein said one section, said other section, and the third section each provide a portion of the structure with a property not provided by the other sections.

In a still preferred construction, the above unitary structure is a steel connector portion and said one section is intended to be threaded or profiled, and said other section facilitates welding of the connector portion to a length of drill pipe.

In a still further preferred construction, the third annular section is a corrosion resistant metal providing the steel connector with a portion which is corrosion resistant.

There is still further disclosed herein a method of forge forming a unitary structure from layers of metal including the steps of:

providing a first layer of ductile metal;

providing a second layer of stronger metal;

abutting the two layers so that mating surfaces substantially exclude atmosphere;

forcing a punch member via a forging process into the layers so as to plastically deform both layers to form sections from the layers, which sections surround an aperture formed by the punch.

## BRIEF DESCRIPTION OF THE DRAWINGS

A preferred form of the present invention will now be described by way of example with reference to the accompanying drawings wherein:

Figure 1(A) to Figure 1(E) are schematic perspective view of the manufacture of a female or male connector portion of a connector set;

Figure 2(A) to Figure 2(E) are schematic sectioned side elevations of the connector portion of Figure 1;

Figure 3 is a schematic perspective view of a finished female connector blank;

Figure 4 is a schematic perspective view of a finished male connector blank;

Figure 5 is a schematic sectioned side elevation of a substantially finished female connector blank;

Figure 6 is a schematic sectioned side elevation of a substantially finished male connector blank;

Figures 7 to 11 are schematic sectioned side elevations of female or male connector portions of a connector set;

Figure 12 is a schematic part sectioned side elevation of a female or male connector portion of a connector set;

Figures 13 to 15 are schematic sectioned side elevations of the blank of Figure 3 and the various stages of manufacture to transform the blank to a partly finished connector portion;

Figures 16 to 18 are schematic side elevations of the blank of Figure 8, and the various stages of manufacture to transform the blank to a partly finished connector portion;

Figures 19 to 21 are schematic sectioned side elevations of the blank of Figure 11, and the various stages of manufacture to transform the blank to a partly finished connector portion;

Figure 22 is a schematically sectioned side elevation of a connector pair connected to pipe sections;

Figure 23 is a schematic side elevation of the connector pair and pipe sections of Figure 22;

Figure 24 is a schematic sectioned side elevation of a further connector pair;

Figure 25 is a schematic sectioned side elevation of a flange;

Figure 26 is a schematic sectioned side elevation of a gear wheel;

Figure 27 is a schema~~tic s~~ectioned side elevation of a wheel;

Figure 28 is a schematic sectioned side elevation of a bearing race;

Figure 29 is a schematic sectioned side elevation of a slew ring; and

Figure 30 is a schematic sectioned side elevation of a crusher ring.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

In Figures 1, 2, 3 and 5 of the accompanying drawings, there is schematically depicted a female connector blank in the various stages of manufacture. The finished blank is then machined so as to be internally threaded or profiled.

The finished female blank 10 is of an annular configuration having a generally cylindrical outer surface 11 and an internal surface 12 radially tapering to a neck 13. The internal surface 12 is threaded or profiled to engage the threaded or profiled portion to be formed on the male connector portion 14 of Figures 4 and 6. The surface 12 surrounds a central longitudinally extending passage 15 within which the connector

portion 14 is located when the portions 10 and 14 are connected.

The female portion blank 10 is formed from a cylindrical member 16 of relatively ductile steel which is easy to weld, such as mild steel. The member 16 is drilled or punched to have a central passage 17 so that the member 16 is then of a generally torroidal configuration.

An insert 18 is pressed into the passage 17 to form an assembled initial blank 24. The insert 18 is formed of a relatively strong material, such as an alloy steel or stainless steel, which when threaded or profiled will have sufficient strength to withstand the forces transmitted between the joined connector portions formed from the finished blanks 10 and 14.

By means of forging, the initial blank 18 is deformed to the shape illustrated in Figure 1(E) and Figure 2(E). More particularly, a punch is forced through the insert 18 forging together the remainder of the insert 18 and the member 16. A central passage 19 is then formed. Accordingly, an interim blank 20 is formed with the member 16 internally lined with the stronger material provided by the insert 18.

The interim blank 20 is ring rolled by the co-operation of shaped mandrils and rolls to the configuration illustrated in Figures 3 and 5. The interim blank 20 is now formed with a neck 13.

The insert 18 now provides a lining to the interior surface of the member 16, and is subsequently threaded or profiled for co-operation with the male connector portion 14.

The male connector portion finished blank 14 is formed by a substantially similar process used to manufacture the finished female connector blank 10. However, the softer more ductile material is located around a central passage 21 and the stronger material, to be threaded or profiled, lines the inner material and provides the outer surface 22. The surface portion 23 is adapted to be threaded or profiled, and to engage the female connector portion.

In Figures 7, 8 and 10, a female or male portion blank 30 is illustrated having a first metal layer 31 of a relatively ductile metal such as mild steel. In intimate contact with the layer 31 is a second layer 32 of stronger metal such as an alloy steel or stainless steel. In the embodiment of Figure 7, the layer 32 is positioned within a passage formed in the layer 31, while in the embodiments of Figures 8 and 10, the layer 32 overlays the layer 31. However in the embodiment of Figure 10, the layer 32 has an entrant portion 33 extending into the layer 31.

In Figures 9 and 11, the female or male portion blanks 40 include a first layer 41 of a ductile metal such as mild steel, a second layer 42 of a stronger metal such as an alloy steel or stainless steel, and a third layer 43 of corrosion resistant metal, such as inconel. The layer 42 would have a projecting portion 44 of generally cylindrical configuration extending into a passage of corresponding configuration in the layer 41. The layer 43 would be of torroidal configuration. In the embodiment of Figure 9, the projecting portion 44 extends through the layer 41, while in the embodiment of Figure 11, the projecting portion 44 extends only partly into the layer 41.

When any one of the blanks 30 or 40 are deformed in a forge press, a punch is forced longitudinally through the blank 30 or 40 to form a central passage. For example, in Figure 12 there is schematically depicted a blank portion 50 already deformed by the punch. A central passage 51 is formed and the various layers 52 to 56 plastically deformed so as to extend axially of the female portion blank 50.

The layers 52 to 56 could be of a variety of materials including ductile, stronger materials and corrosion resistant materials.

In the embodiments of Figures 7 to 11, it could be found advantageous to heat the blanks 30,40 to a temperature within the range of 850°C to 1300°C. However it is also possible to forge the blank 30,40 at lower temperatures. It is even possible to cold forge the blank 30,40. It may also be advantageous to coat the mating surfaces between the layers with a metal such as nickel. As a still further modification a weld bead could follow the periphery of the junction between the mating surfaces so as to hold them together in contact and seal the mating surfaces from atmosphere. As a still further modification, the use of a weld could be eliminated if the surfaces closely mate.

In a still further modification the blanks 30,40 could be heated and placed in a press to provide an initial bond between the layers prior to being subjected to the forging process.

In the embodiments of Figures 9 and 11, the blanks 40 would be preferably raised to a temperature of 925°C to 1260°C.

Turning now to Figures 13 to 15, wherein the blank 30 is again illustrated. The blank 30 would be forged so that the layers 31 and 32 at their interface would become forge welded so as to be integrally bonded. As can be seen, the layer 32 has been deformed so as to line a significant portion of the passage 33. The blank 30 is then machined to provide a semi-finished article as best seen in Figure 15.

In Figures 16 to 18, the blank 30 is deformed by forcing the layer 32 longitudinally through the blank 13 to line the longitudinal passage 33. Again the blank 30 would be machined to provide a semi-finished article as best seen in Figure 18.

In Figures 19 to 21, the blank 40 is deformed by the punch so that the layers 42 and 43 extend longitudinally through the blank 40. The blank 40 would then be machined to provide a semi-finished article as seen in Figure 21.

In the embodiments of Figures 9, 11 and 19 to 21, the female connector eventually provided has a corrosion resistant portion provided by the layer 43.

As discussed previously, the stronger material is intended to be threaded or profiled to provide a good mechanical coupling between the male and female connectors. The ductile material is intended to be welded to a length of pipe.

In the embodiment of Figures 13 to 15, the radially inner layer 32 is co-extensive and co-axial with respect to the radially outer layer 33.

In the embodiment of Figures 16 to 18 the inner layer 32 (Figure 17) is initially co-extensive and co-axial with respect to the outer layer 31, however after machining (Figure 18) the layer 31 nad 32 are only co-axial.

In the embodiment of Figures 19 to 21, the layers 41, 42 and 43 are initially (Figure 20) generally co-extensive and co-axial, however they are machined to be only co-axial (Figure 21). The layer 43 (Figure 21) is spaced axially from the layer 42, after machining.

In Figures 22 and 23 there is schematically depicted a connector pair 50 connecting two lengths of pipe 50 and 51. The connector pair 50 includes a female connector portion 52, and a male connector portion 53. Each connector portion 52 and 53 includes a ductile metal section 57 welded to an associated length of pipe 50 or 51 by means of a weld 58. Each section 57 is forge connected to a stronger section 54, which in turn is forge connected to a corrosion resistant section 56. The corrosion resistant sections 56 co-operate to sealingly connect the connector portions 52 and 53. The sections 54 may snap engage or may threadably engage to retain the connector portions 52 and 53 connected.

In the embodiment of Figure 24, the connector pair 60 include a female connector portion 61 and a male connector portion 62. Each connector portion 61 and 62 includes a section 63 of a ductile metal welded to a length of pipe 64 by means of a weld 65. Each connector

portion 61 and 62 further includes a section 66 of stronger metal which may be threaded or otherwise profiled so that the sections 66 threadably or snap engage to secure the connector portions 61 and 62 together. Each connector portion 61 and 62 further includes a corrosion resistant section 67 which engage to sealingly connect the connector portions 61 and 62.

In Figures 25 to 30, there is schematically depicted various articles which may be manufactured from the unitary structure manufactured by the forging process previously described. In the embodiments of Figures 25 to 30, the items 60 are manufactured so as to have concentric sections 61 and 62, with the section 61 being formed from a stronger metal, and the section 62 from a more ductile metal. As a further alternative one of the layers may be corrosion resistant material. As a still further alternative, additional layers may be incorporated as discussed previously.

The punch member used to form the forged product may have a circular transverse cross-section. However other cross-sections are contemplated, such as hexagonal and octagonal, where the punch has a number of longitudinal sides. Accordingly the punch forms generally annular sections surrounding the punch when it plastically deforms the layers and forms an aperture therein.

CLAIMS: 

1. A unitary structure of metal layers, said structure being of a generally annular configuration and consisting of a laminated structure so as to have a radially inner section and a radially outer section forged connected to the inner section so as to be integrally bonded thereto, and wherein one section consists of a layer of strong metal to provide a portion of the structure with mechanical strength, and the other section consists of a layer of more ductile metal to provide a portion of the structure with another property not provided by said one section.

2. The unitary structure of claim 1, including at least a third section consisting of a third metal layer, with the sections being arranged generally concentric and forge connected so as to be integrally bonded thereto, and wherein said one section, said other section, and the third section each provide a portion of the structure with a property not provided by the other sections.

3. The unitary structure of claim 2, wherein the third section is formed of a corrosion resistant metal.

4. The unitary structure of claim 1, 2 or 3, wherein the unitary structure is a steel connector portion and said one section is intended to be threaded or profiled, and said other section facilitates welding of the connector portion to a length of pipe.

5. A method of forge forming a unitary structure from layers of metal including the steps of:

providing a first layer of ductile metal;

providing a second layer of stronger metal;

abutting the two layers so that mating surfaces substantially exclude atmosphere;

forcing a punch member via a forging process into the layers so as to plastically deform both layers to form sections from the layers, which sections surround an aperture formed by the punch.

6. The method of claim 5, further including providing a third layer to be plastically deformed by the punch together with the first and second layer so as to form a further section.

7. The method of claim 5 or 6, wherein said third layer is a layer of corrosion resistant material.

8. The method of claim 5, 6 or 7 wherein the layers are raised to a temperature within the range of 850°C to 1300°C for engagement by the punch.

9. The method of any one of claims 5 to 8, further including securing the layers together prior to engagement with the punch.

10. A unitary structure substantially as hereinbefore described with reference to the accompanying drawings.

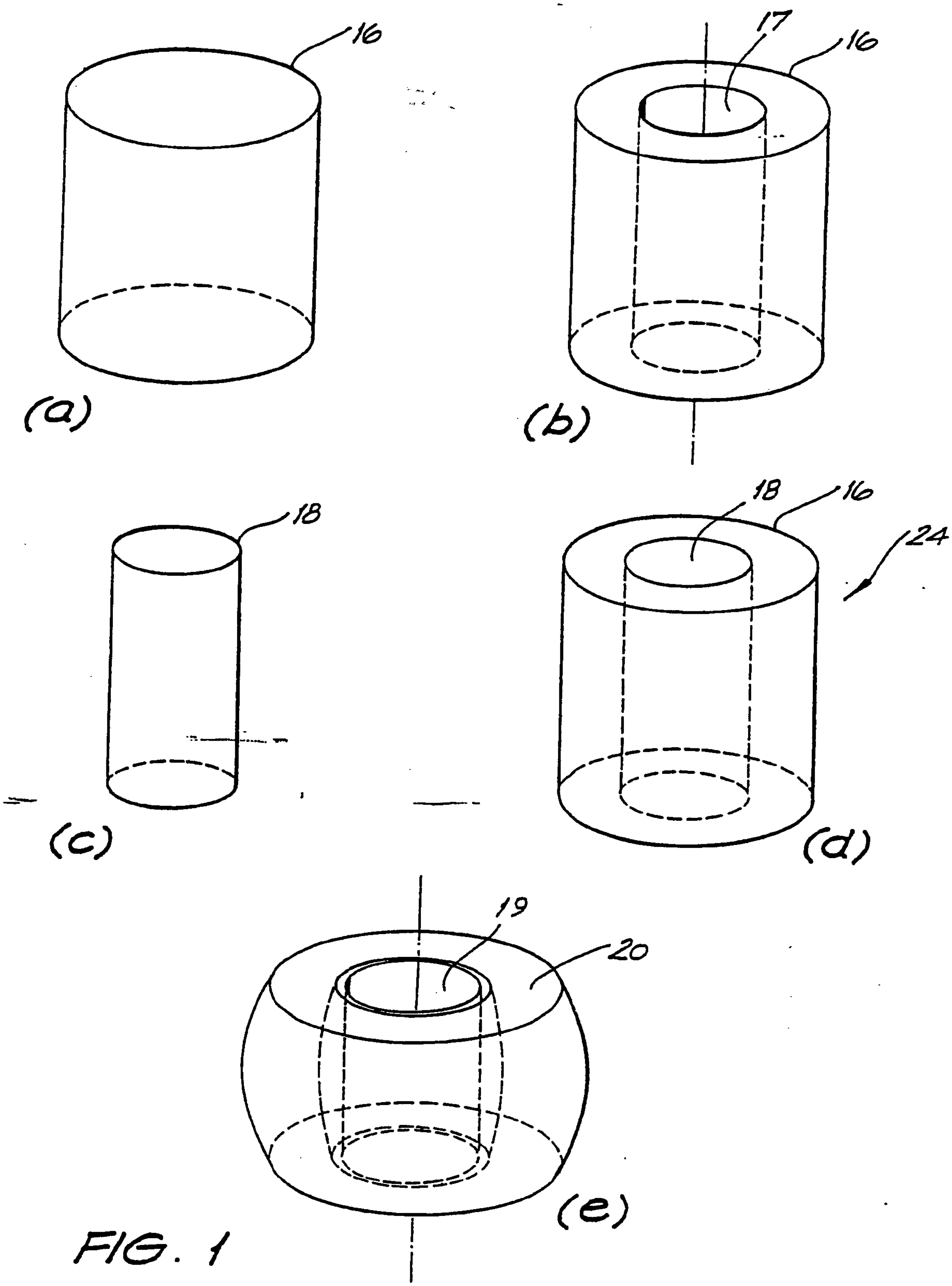


FIG. 1

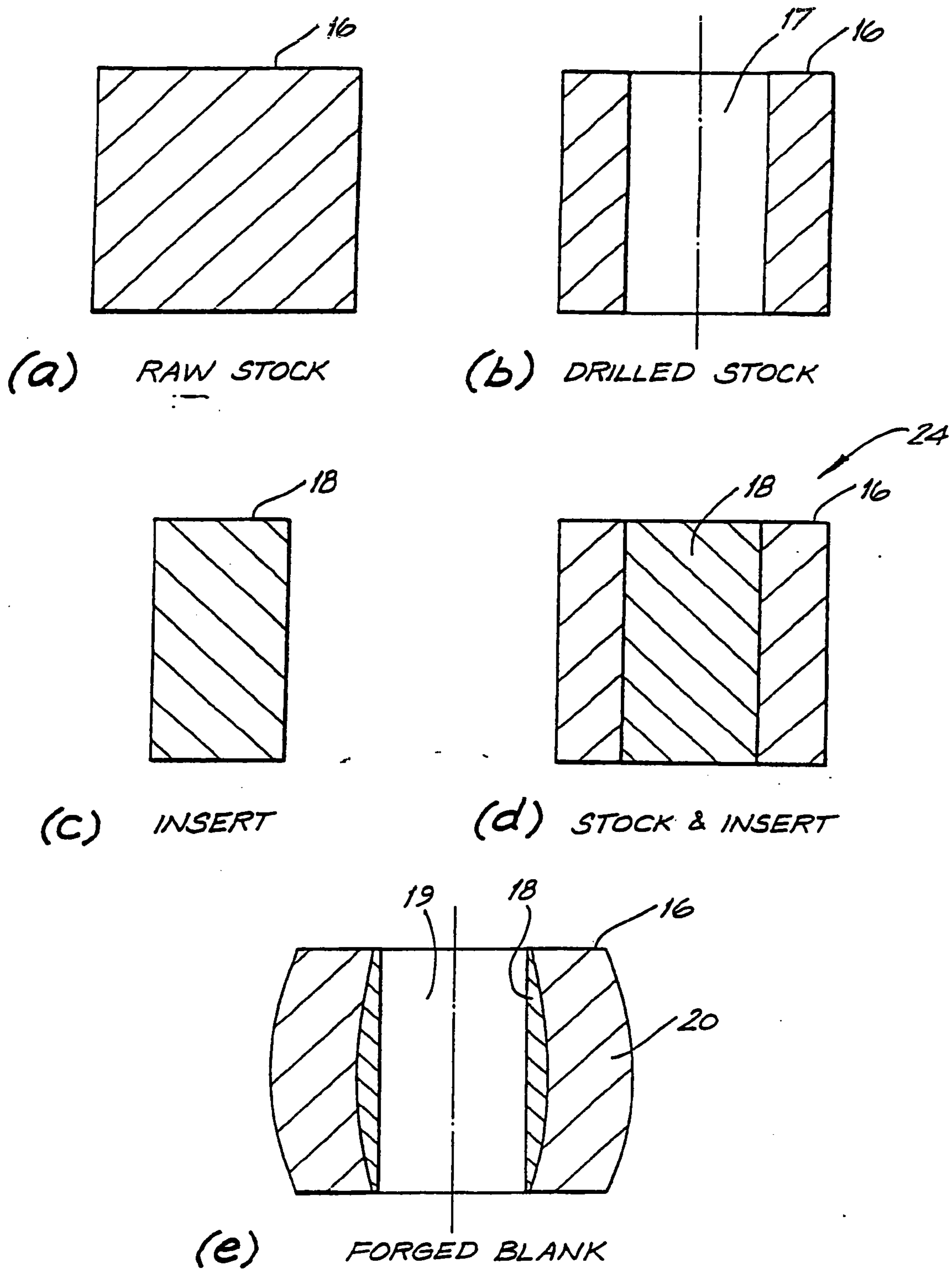
16
17
16
(a) RAW STOCK
(b) DRILLED STOCK
24
18
18
16
(c) INSERT
(d) STOCK & INSERT
19
18
16
20
(e) FORGED BLANK

FIG. 2

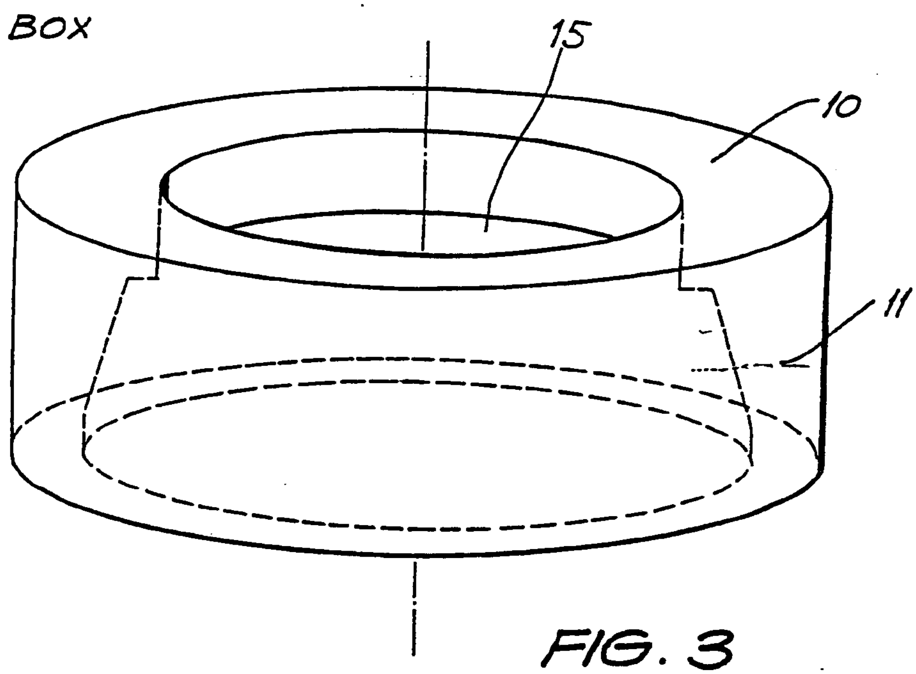


FIG. 3

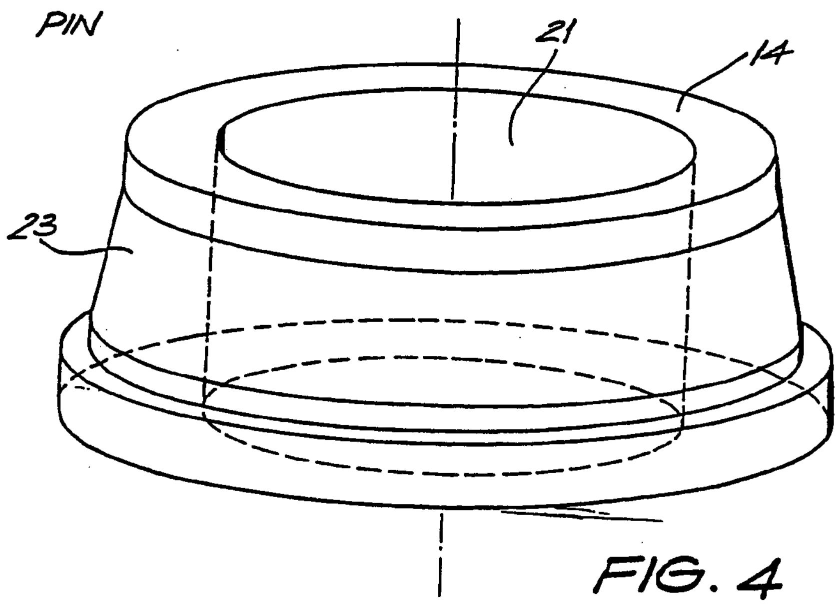


FIG. 4

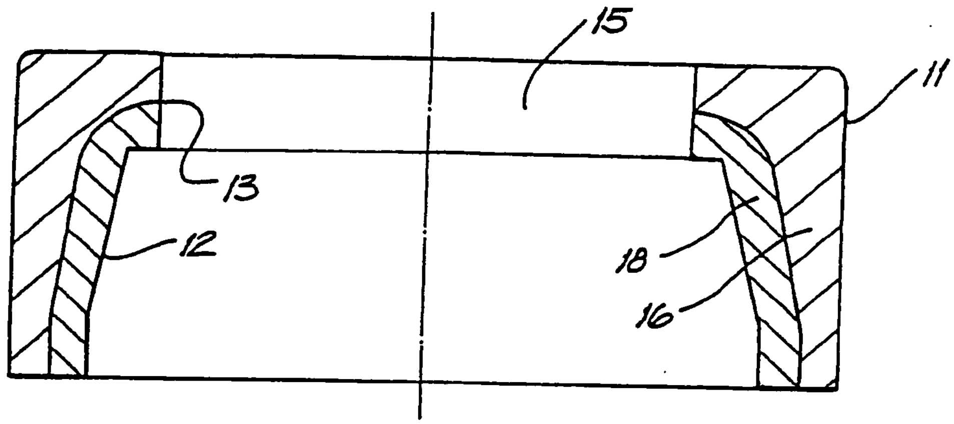


FIG. 5

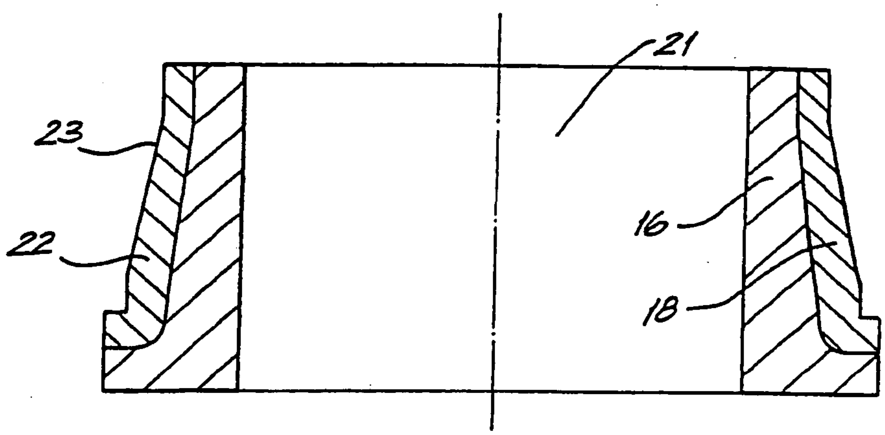


FIG. 6

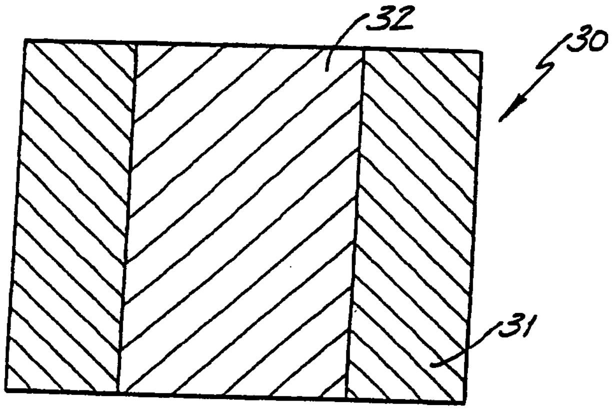


FIG. 7

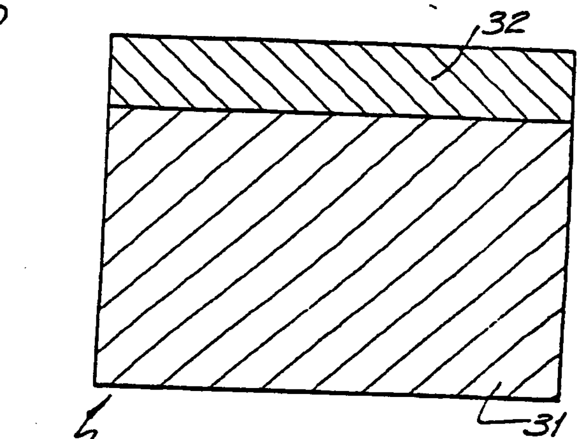


FIG. 8

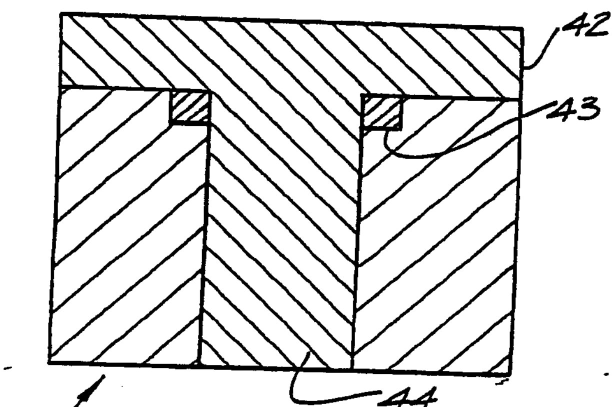


FIG. 9

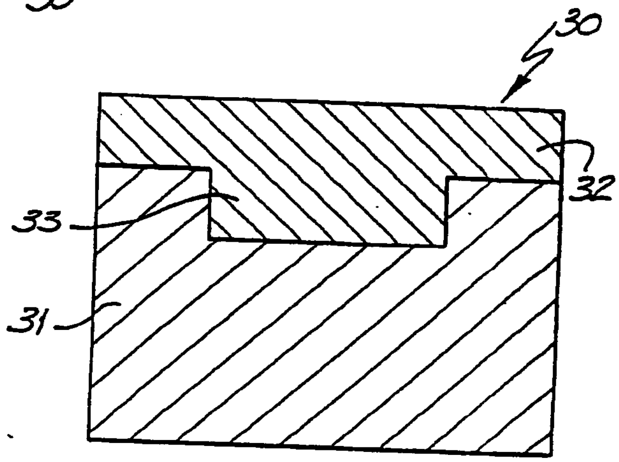


FIG. 10

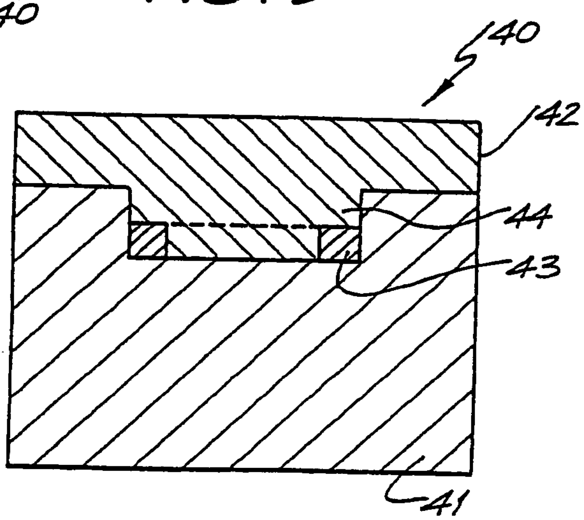


FIG. 11

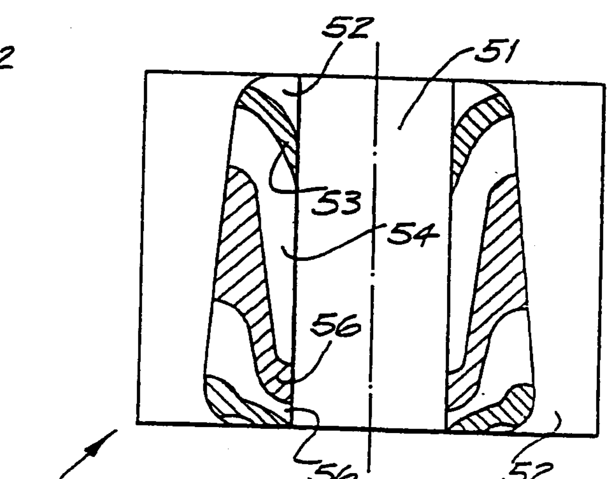


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FIG. 12

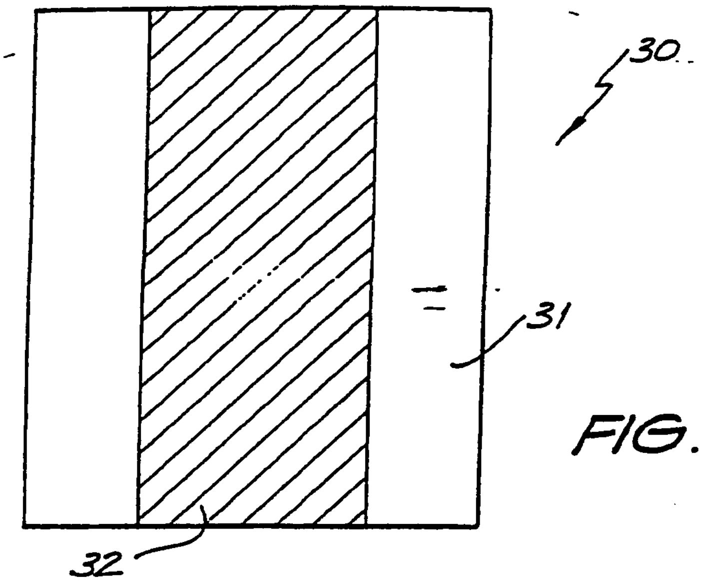



FIG. 13

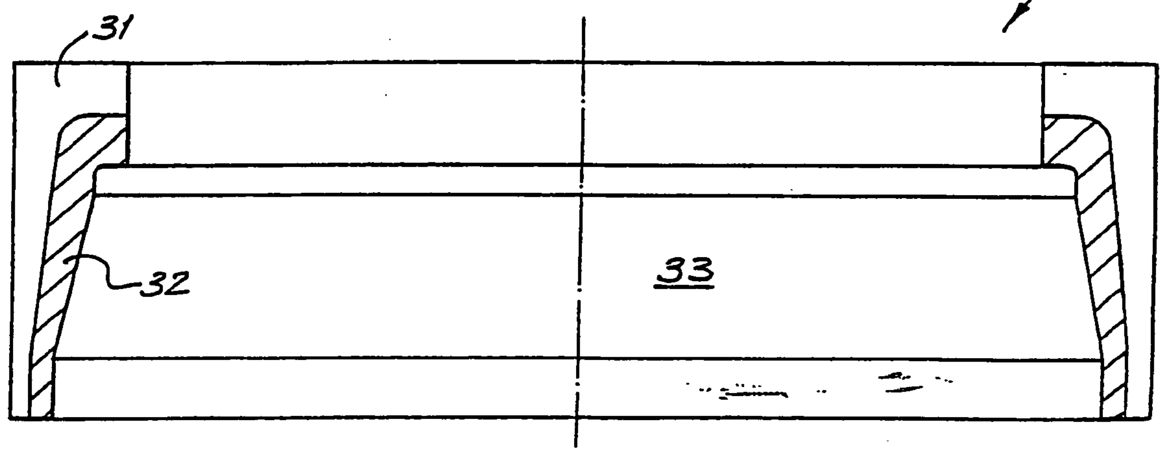



FIG. 14

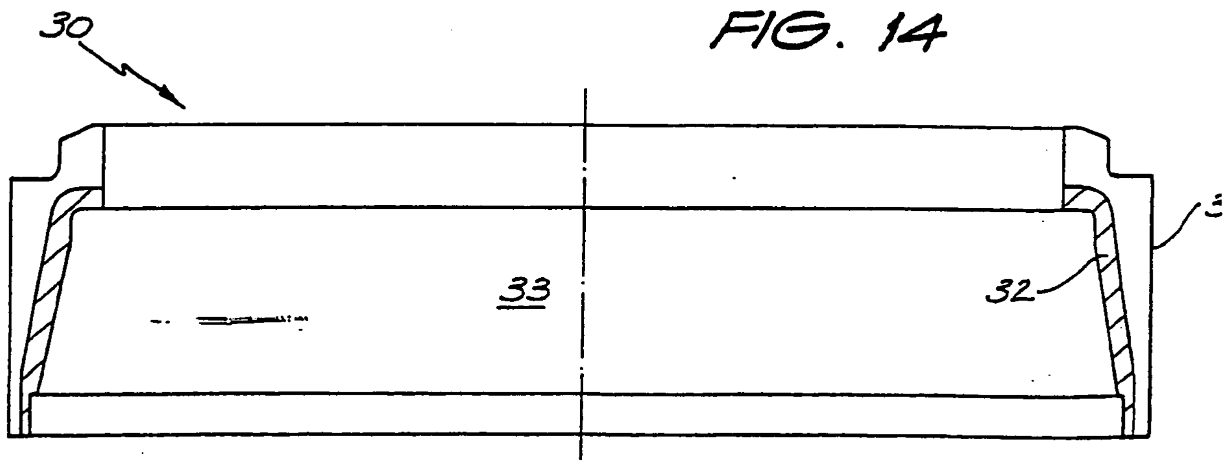



FIG. 15

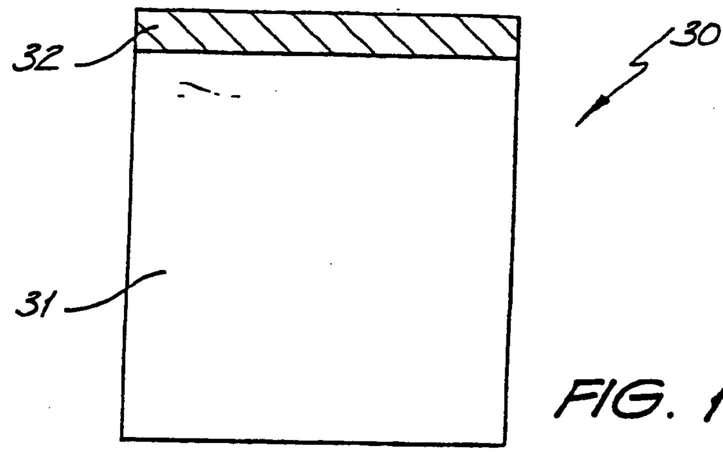



FIG. 16

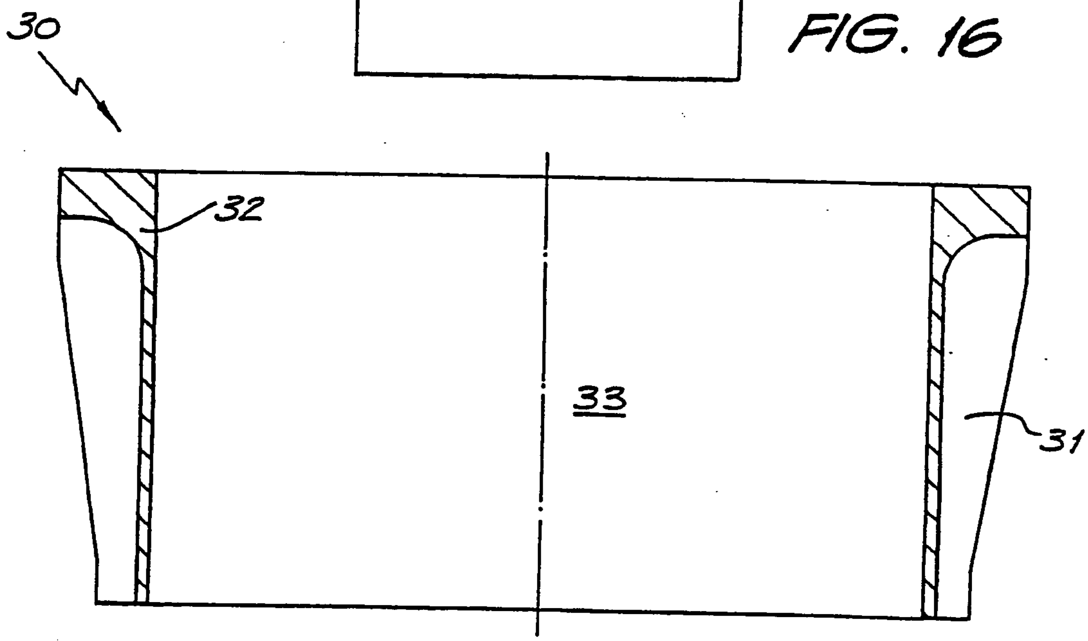



FIG. 17

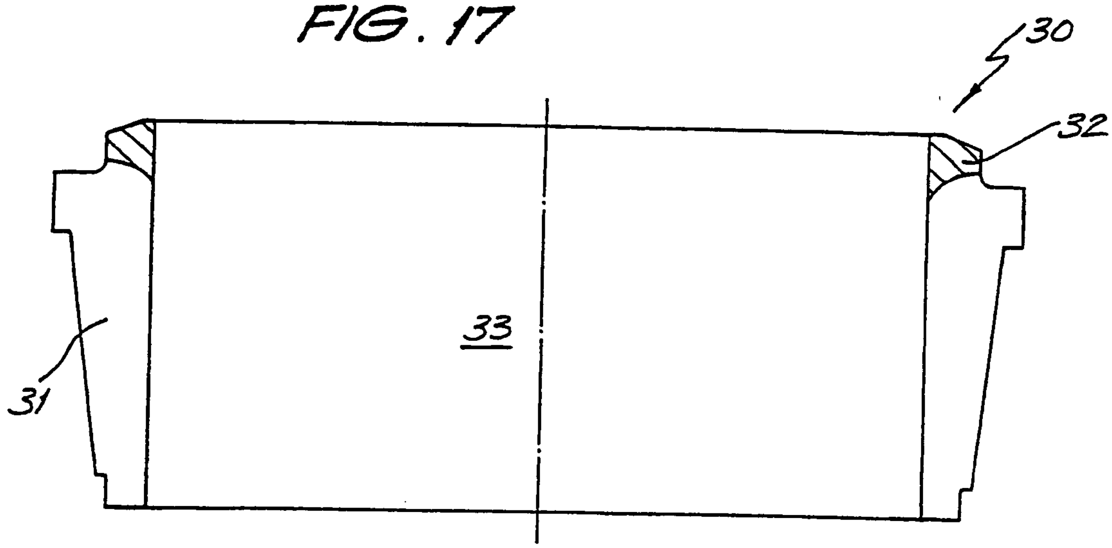



FIG. 18

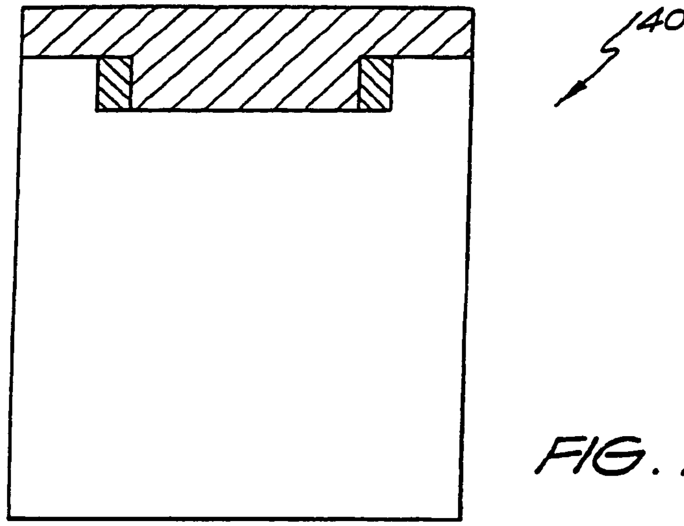



FIG. 19

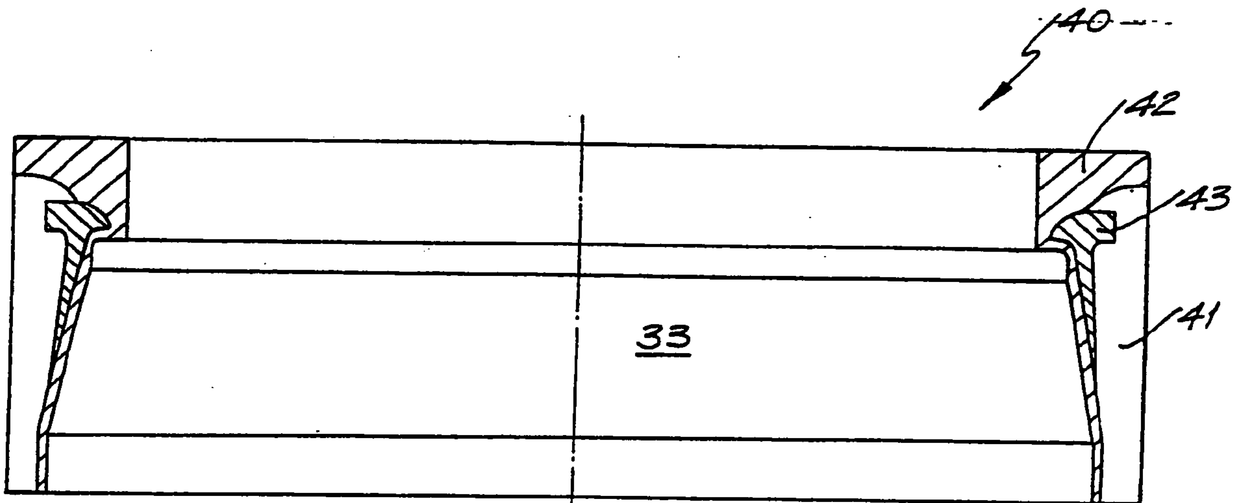
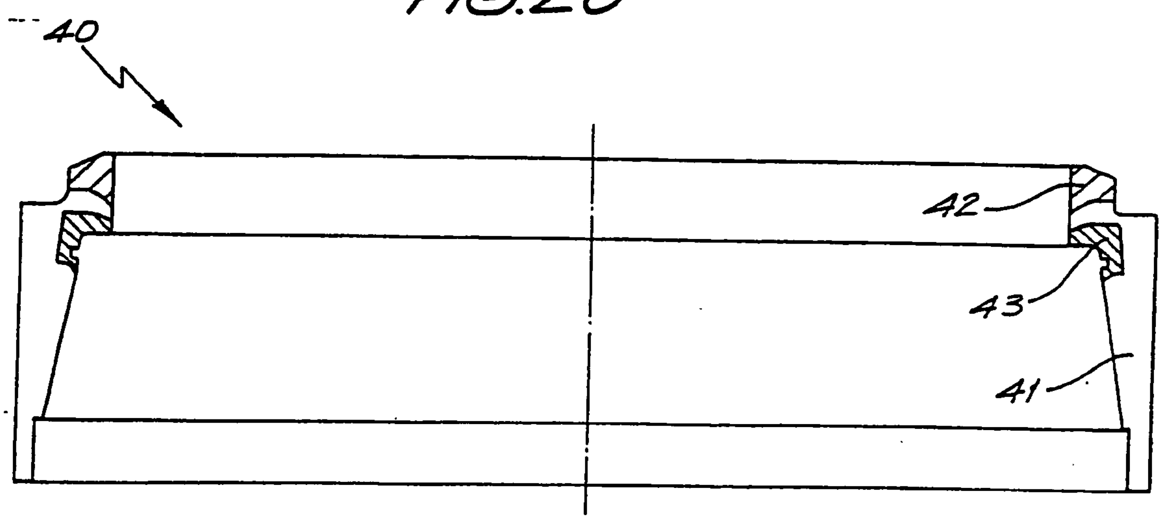



FIG.20




SUBSTITUTE SHEET FIG. 21

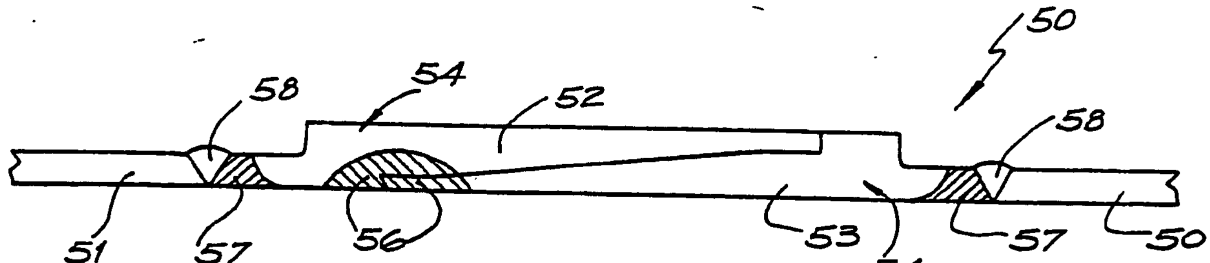



FIG. 22

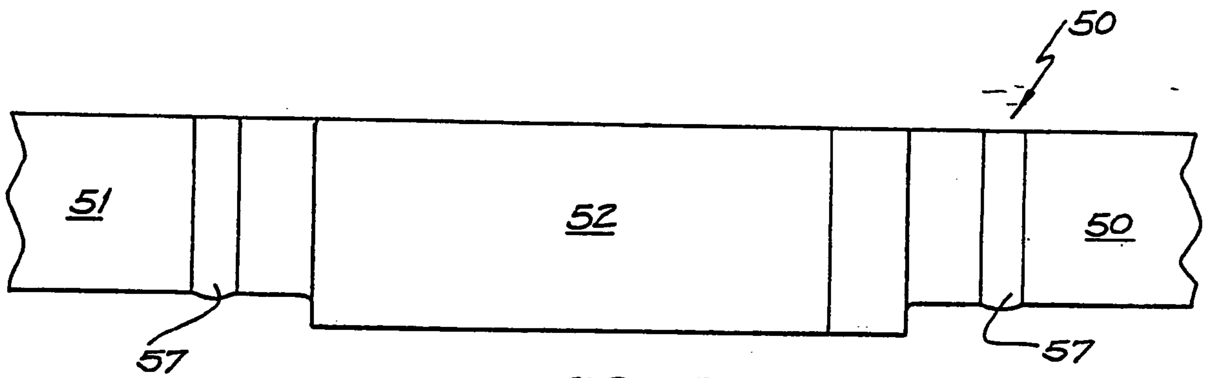



FIG. 23

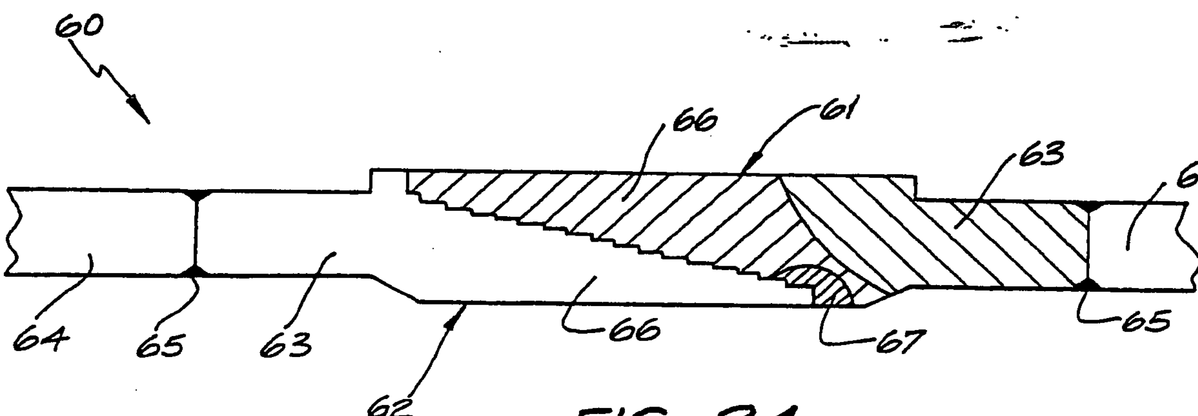



FIG. 24

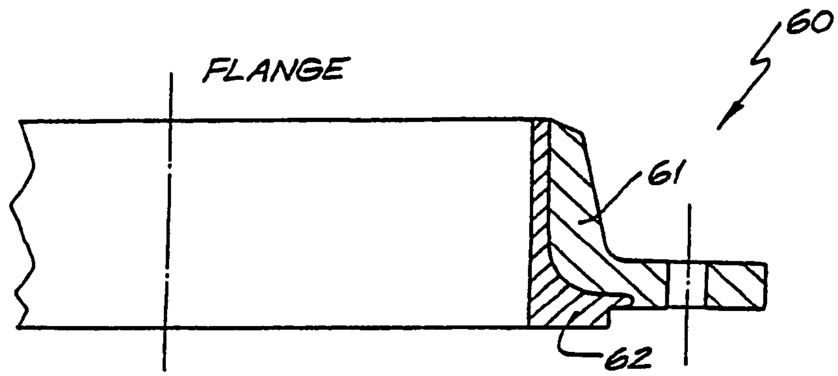



FIG. 25

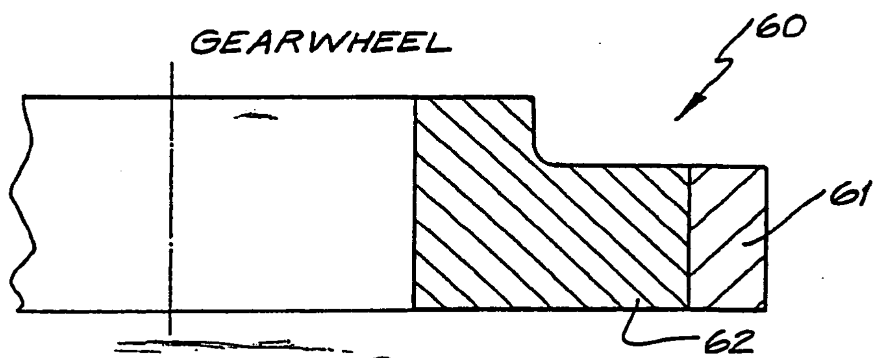



FIG. 26

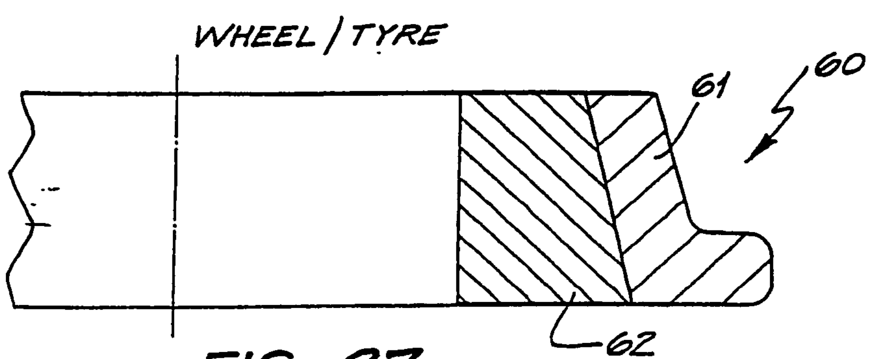



FIG. 27

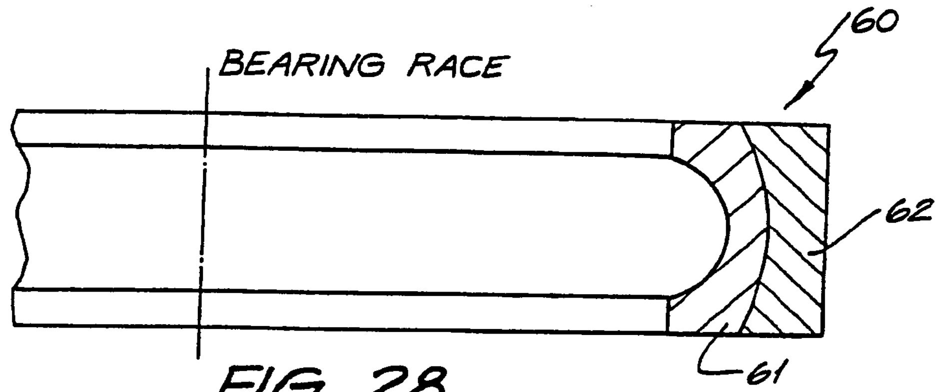



FIG. 28

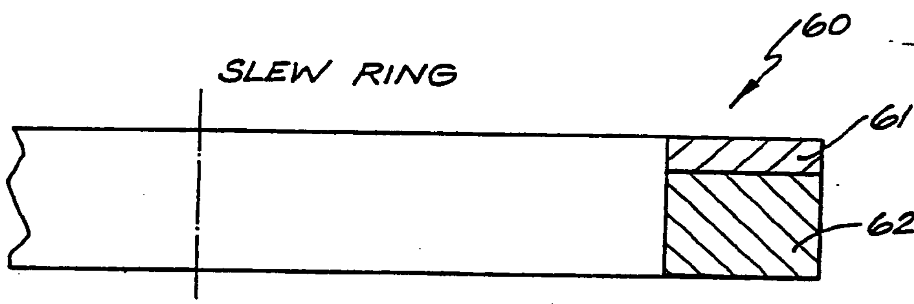



FIG. 29

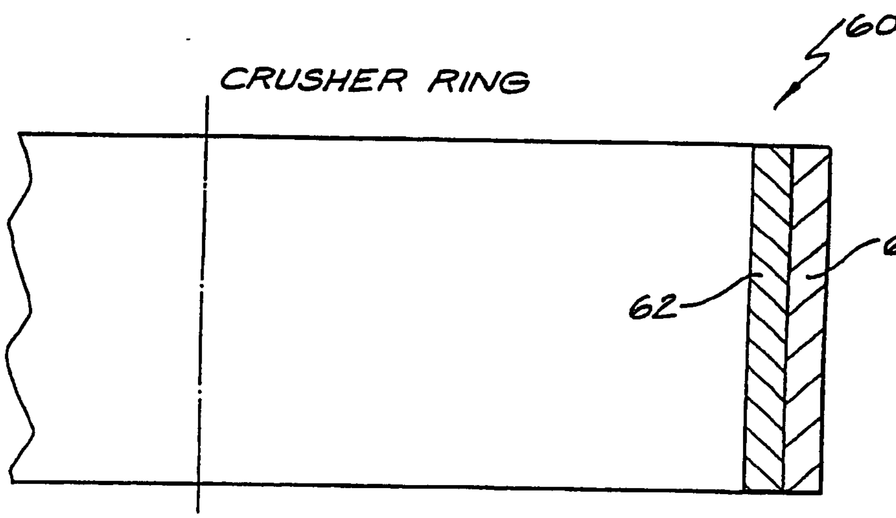



FIG. 30